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Newfoundland Region

INTERIM REPORT ON THE PERFORMANCE AND COST EFFECTIVENESS OF A SIMNAR SHOAL FISH HEADING/EVISCERATING MACHINE

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Canada

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Interim Report on the Performance and Cost Effectiveness of a Simnar Shoal Fish Heading/Eviscerating Machine Presently on Trial at P. Janes and Sons Limited Hant's Harbour, T.B., Newfoundland

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ABSTRACT

A Simor shoal fish heading and eviscerating machine, purchased through the Department of Fisheries and Oceans, Fisheries Development Branch, was located in the Hant's Harbour plant of P. Janes and Sons Limited, in order to evaluate its performance and cost effectiveness in dressing male capelin.

The machine was used for two continuous weeks of production, dressing defrosted male capelin which were subsequently processed into either breaded, IQF dressed, or canned capelin products.

Although initial "teething problems" in setting the machine for optimum performance were experienced, over the production period throughputs increased one hundred and seventy six percent (176%), the best obtained performance being approximately five times that achievable by a manual operation. It is expected that further production will show improved machine performance, especially when processing fresh male capelin.

The overall machine design with respect to operation, repairs and maintenance, and cleaning and sanitation is efficient. Two design modifications have been recommended.

The cost efficiency of mechanically eviscerating male capelin in comparison to a manual operation has transformed the secondary processing of high quality capelin products into an economically viable proposition.

INTRODUCTION

Since 1980, P. Janes and Sons Limited has been involved in the production of secondary processed capelin products, in canned and frozen form. The capelin have been dressed by nobbing, and the tails removed by hand. This method has a number of negative factors in the production of capelin:

a) high labour cost;

b) incomplete removal of gut material;

c) inconsistent length, necessary for canned products.

In 1986, in a development program funded by the Department of Fisheries and Oceans' Development Branch, an aesthetically acceptable breaded capelin product was produced. The negative comments on this product were that an unacceptably high percentage of the capelin has gut material remaining, which gave the product a strong, bitter after taste.

In 1987, a subsequent development program investigated the feasibility of dressing capelin by hand, ensuring complete evisceration. This overcame the problem of the presence of gut material, but did not address the issue of inconsistent length. The labour costs of hand dressing were very high. If these were applied to the final sales prices of the product, it would meet total price resistance in the marketplace.

In order to overcome all of the negative factors itemized above, it was decided to investigate the possibility of mechanically dressing capelin. A shoal fish gutting machine, produced by Simnar Incorporated of Windsor, Ontario, and originally designed for dressing smelt from the Great Lakes fishery, was selected as being the most suitable of available

machines. As a result of test trials using capelin, the original design was modified to specifically handle capelin and a test unit purchased by the Ministry of Supply and Services. This unit was installed in the Hant's Harbour facility of P. Janes and Sons Limited in July, 1987. This report details and analyzes the performance and cost effectiveness of this machine to date.

CAPELIN EVISCERATING MACHINE - DETAILS AND SPECIFICATIONS

Name:	Simor Shoal Fish Eviscerating Machine
Producer:	Simnar Incorporated
Address:	1585 Moro Drive
	R.R.1, Windsor, Ontario N9A 6J3
Power Supply:	600 v 3 phase
Infeed Conveyor:	Two (2) station, right hand feed
Infeed Rate:	One hundred and forty (140) fish per minute with two operators
Head Cutting Blade:	To be positioned to remove pectoral fins
Tail Cutting Blade:	To be installed, to be adjustable to trim length from 3 - 3/4" - 4 - 1/4"
	To be protected by removable guard supplied with suitable limit switches

Conveyor Belt: To be constructed so that a minimum of ninety percent (90%) of correctly fed fish, enter the eviscerating blades in the correct orientation

Eviscerating Blades: Three shafts, to comprise, one blade, one bronze wheel, one nylon brush, to ensure complete removal of viscera and black belly membrane

Overall Performance: A minimum of ninety percent (90%) of undamaged male capelin, lying in a horizontal plane, with the ventral surface facing left, are completley eviscerated, and the head and pectoral fins removed

Construction: To be a combination of stainless steel, aluminum and food approved plastics

The purchasing specifications are itemized in Appendix A.

CUSTOM MODIFICATIONS

To comply with the above purchasing specifications, a number of modifications were made to the standard design model. These were made after test runs of capelin through existing in-plant models in Wheatley, Ontario, and in consultation with P. Janes and Sons Limited.

Infeed Conveyor

The conveyor buckets were modified to allow the male capelin to slide off in the vertical position. This was necessary for three main reasons:

a) the cross sectional area of a male capelin is angular;

b) the centre of gravity is situated above the mid line;

c) there is a suction effect caused by the spawning ridge.

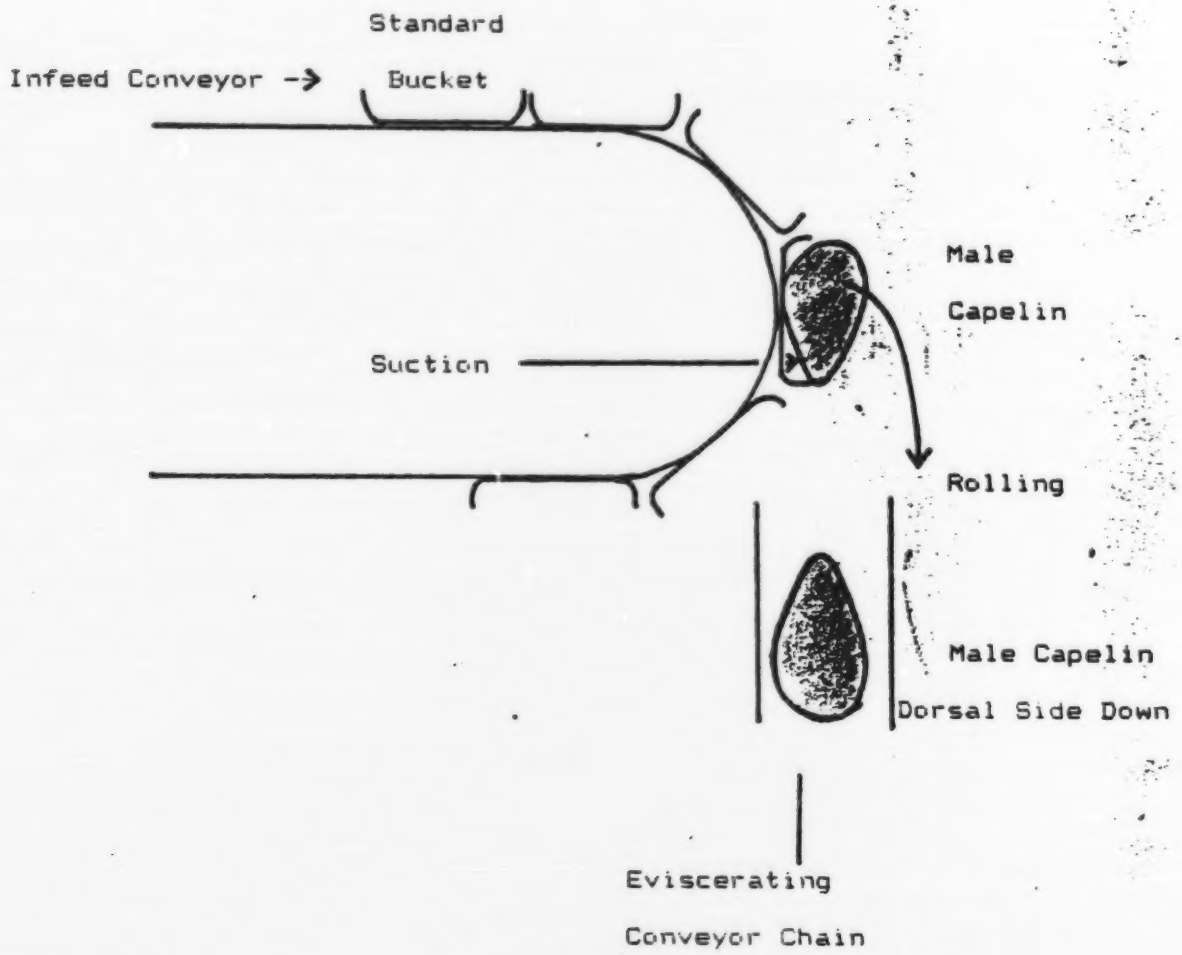
A combination of these effects causes the capelin to roll out of a standard bucket, rather than to fall directly. The capelin therefore enter the eviscerating section of the machine in the wrong orientation (see Figure 1(a)). By modifying the angle on the front section of the buckets, and introducing an extra water jet to reduce suction forces, it was possible to minimize rolling (see Figure 1(b)).

Tail Cutting Blade

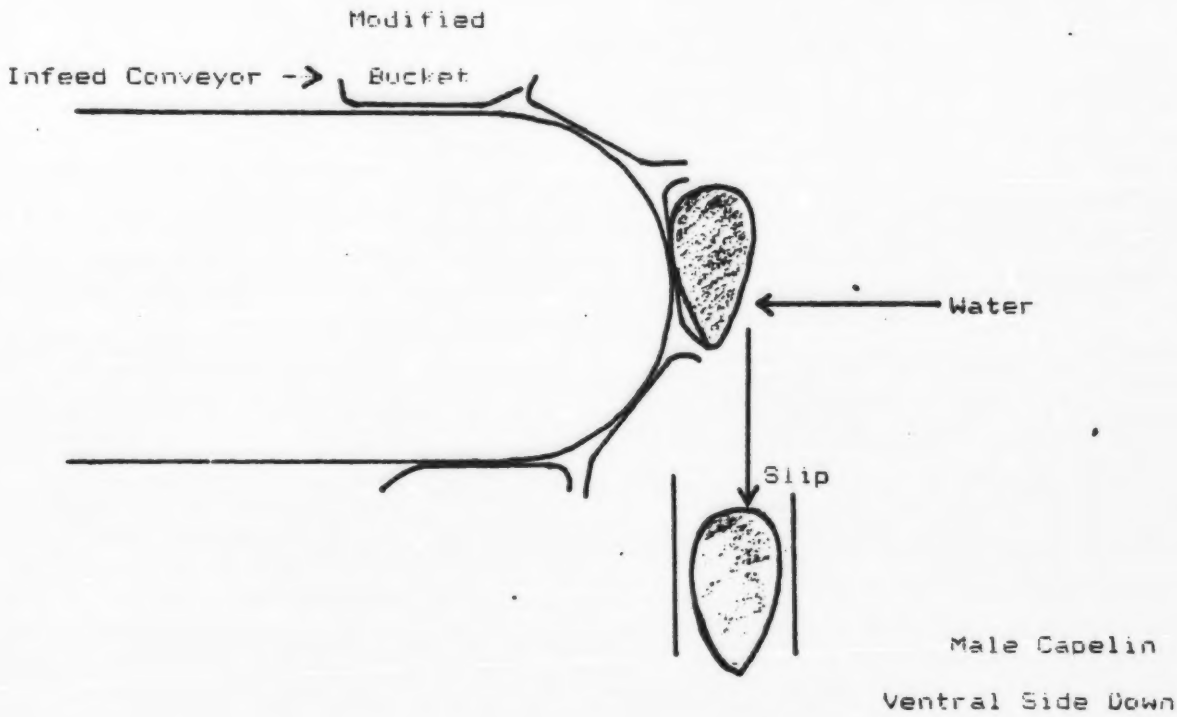
On the standard design model, there are no provisions for tail cutting. It has been shown in previous work that if the tails are left attached to the capelin, these become enmeshed in the conveyor belting of the batter/breading line used by P. Janes and Sons Limited. This causes the capelin to be dragged back into the batter and crumb reservoirs, rather than continuing through the production line. It was also intended to use this machine to dress male capelin for canning purposes. It was therefore a primary requirement that the machine have the capability to cut the capelin to an adjustable standard length.

A tail cutting blade was installed on an extended shaft driving the head cutting blade and shielded by a limit switch-controlled, hinged guard. This is adjustable to cut capelin from 3 - 3/4" to 4 - 1/4" (9.53 cm to 10.8 cm) long. Adjustments are made using a system of spacers which fit over the shaft between the head cutting blade and tail cutting blade (see Figure 2). The spacers are custom made to correspond to the can sizes used in production.

Figure 1 (a) Standard Bucket Design



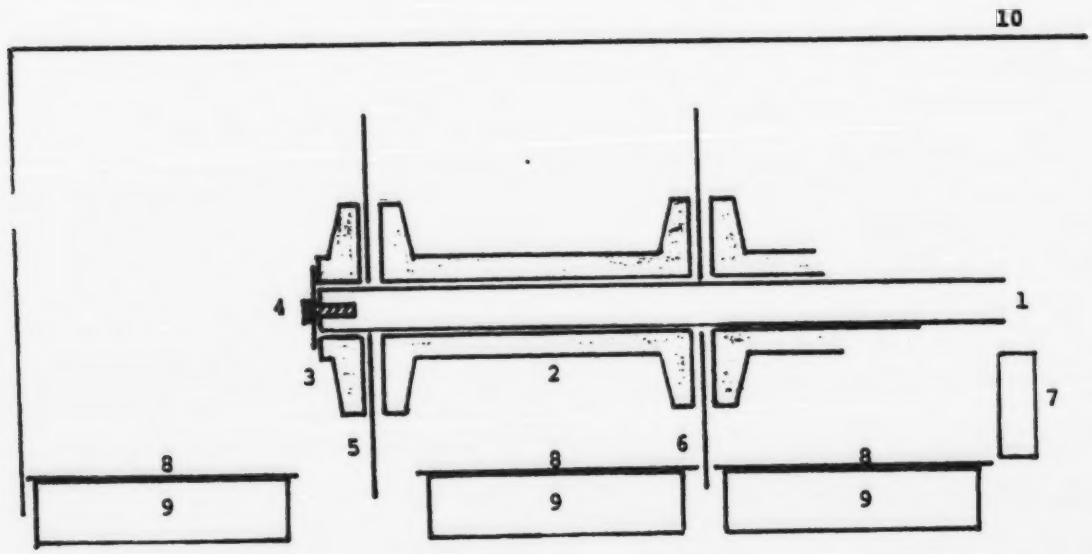
(b) Modified Bucket Design



These modifications do not completely eliminate rolling, but in a production environment, have consistently reduced the number of capelin entering the eviscerating blades in the wrong orientation to less than ten percent (10%).

Figure 2 Conveyor bucket and head and tail cutting blade Configuration

1. Drive Shaft
2. Spacer
3. Skim
4. Lock Screw
5. Tail Cutting Blade
6. Head Cutting Blade
7. Head Guide
8. Three Piece Bucket
9. Feed Conveyor
10. Guard



To accommodate the tail cutting blade, it was necessary to design a three piece bucket, which allowed the tail cutting blade to sever the tail. The spacing between bucket sections was made at 5/8" (16 mm) to permit adjustment of cutting length.

Eviscerating Shafts

The standard design machine has two (2) drive shafts in the eviscerating section. The first shaft drives a notched cutting blade, which slits the belly from the head cut to the anus. The second shaft drives a notched bronze wheel which removes the gut and kidney. The belly cavity is then flushed with water jets before the gutted fish exits the machine.

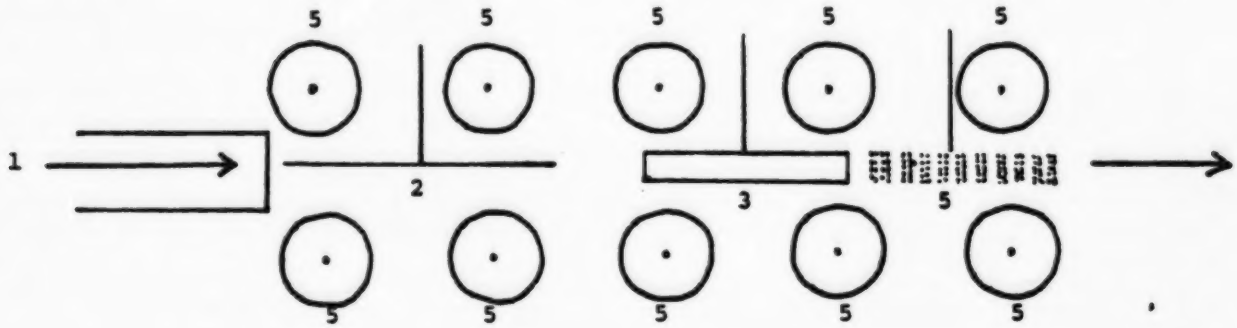
It was found in tests on a standard production model using male capelin that an unacceptably high ratio of capelin had gut remnants and/or the black belly membrane left on the fish. A third shaft was included (see Figure 3) which drives a nylon bristle brush. This removed all remaining gut material and membrane.

MACHINE PERFORMANCE

The manufcturers brochure (available upon request) describes the performance rate at 75 fish/min. per operator, with capacities varying according to fish size and operator efficiency. It was specified in the purchasing specifications that a minimum level of completely eviscerated fish was 90%. These two criteria have been used as the basis for

Figure 3. Schematic drawing of eviscerating section of shoal fish Eviscerating machine viewed from above

1. Conveyor Chain
2. Belly Cutting Blade
3. Bronze Eviscerating Wheel
4. Nylon Eviscerating Brush
5. Spring Mounted Guide Sprockets



A manufacturers brochure describing a standard production Heading/Eviscerating machine for shoal fish is included as Appendix 2.

evaluating the performance of the gutting machine, in addiiton to other general observations.

OPERATOR EFFICIENCY

It is necessary for the machine operators to cull out all damaged capelin, to ensure that they feed the machine with the ventral surface of the fish facing the feed direction, and that the nose of the fish is butting the guide rail. (A rotating brush which is designed to push the fish up against the guide rail was removed. Due to the soft nature of defrosted capelin, this devise "buckled" the fish, resulting in significant inconsistent eviscerating performances). To prevent blockages occuring in the machine, all fish must lie flat in a horizontal plane. Male capelin are frozen in a dump pack. This results in a large number of the defrosted fish being bent in the horizontal plane. These fish must be either straightened, or culled out. To maximize yields, the former option is preferrable. This reduces the speed at which the operator can feed the machine.

The main constraint on operator efficiency to date, has been blockages occuring at the point of transfer from the head cutting conveyor to the eviscerating conveyor, causing down time of the machine. These blockages occur for two reasons.

Blockages Due to Surface Tension Effects

Fish adhering to the conveyor buckets results in the mucus covering the capelin to be very glutinous after the fish is defrosted. This is due to the protein in the mucous denaturing during freezing. The high surface

tension of the mucous causes the capelin to adhere to the conveyor buckets. When this occurs, instead of falling onto the eviscerating conveyor chain, the fish are dragged back under the head cutting conveyor and become trapped between the conveyor buckets and guard plate (see Figure 4). This presents a problem of fish consistently falling onto the eviscerating conveyor. They become wedged between the guides, and cause a machine blockage.

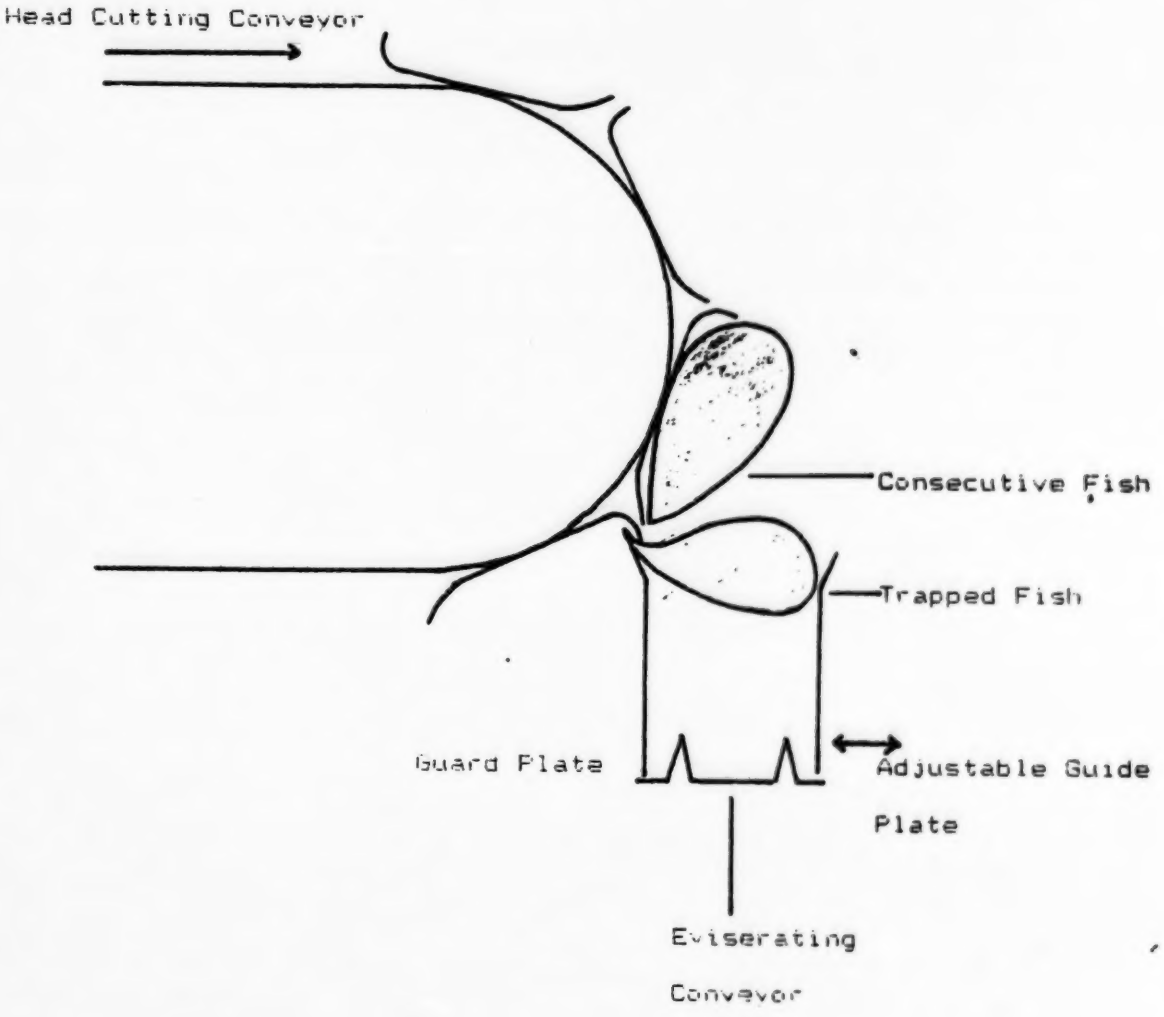
This problem has been overcome to a certain degree by installing additional water jets immediately prior to the transfer point. If during future use this problem continues at an unacceptable level, it is planned to install a drip feed oiler. This will involve coating the conveyor buckets with a thin film of vegetable oil each time the conveyor revolves. The lubrication of the buckets should prevent the capelin from being dragged back into the guard plate.

It is not envisaged that this operational problem will occur when using fresh capelin.

Blockages due to Variation in Fish Size

When large fish become wedged between the guide plates, the adjustable guide plate has to be set within very narrow limits when processing capelin. If the guides are opened to a point where they will accommodate the largest fish, rolling (refer 2.1.1) occurs at an unacceptably high level with the smaller fish. If the guides are closed to prevent rolling in the average sized fish, the larger fish become wedged between the guides, causing a machine blockage. This problem can only be overcome by size grading the capelin prior to feeding the machine. This can be

Figure 4. Schematic diagram of the interphase between the head cutting conveyor and eviscerating conveyor of the Simor Shoal Fish Heading/Eviscerating Machine



This problem has been overcome to a certain degree by installing additional water jets immediately prior to the transfer point. If during future use, this problem continues at an

performed manually by the operators, the largest fish being culled out. This system should minimize blockages, but can only be achieved over a period of time by operator experience. It may be possible to mechanically grade the male capelin. This would be most feasible during the capelin season by installing a separator on the end of the male capelin inspection belt. This option is to be investigated for the 1988 capelin season.

Blockages due to Asynchronous Belt Speeds

Withstanding the above constraints, it has been found that if consecutive buckets are loaded, the eviscerating conveyor does not completely remove each capelin from the interphase (see Figure 4) before the consecutive capelin falls on top of it. Recent telephone discussions with the machine manufacturer have indicated that the asynchronicity between the infeed conveyor and eviscerating conveyor may be corrected by adjustment of the pulley diameter on the eviscerating conveyor drive. This is to be investigated when the eviscerating machine is next in use.

As demonstrated by the above discussion, operator efficiency has been restricted dur to "teething problems" with the setting up of the machine. Operator familiarity and set up experience have increased throughput (gutted weight) from 785 lbs. per eight hour shift at initial start up to 1,382 lbs. per eight hour shift after two weeks continuous use. Using the standard factors of:

Average round count - 16 capelin/lb.

Average yield - 68%

Working minutes per shift - 450

Operators - 2

These throughput figures translate to 21 fish per operator minute at start up to 37 fish per operator minute after two weeks of operation. This represents an increase in operator efficiency of 175%. If down time due to blockages is estimated at 10 percent then the latter figure is 40 fish per minute.

It is predicted that if the transfer problems discussed in this section (Operator Efficiency) can be rectified, then feed rates of 50 fish per minute are achievable when processing defrosted capelin. It is not foreseeable that a much higher figure will be achieved due to the inherent problems of damaged and fish of various shapes which must be culled. It may be possible to achieve higher feed rates when processing fresh capelin. This will be evaluated during the 1988 capelin season.

MACHINE EFFICIENCY

Machine "set up" criteria have been discussed above with respect to their constraints on operator efficiency. Therefore, this subsection will deal with the head cutting, tail trimming and eviscerating efficiency of the machine, and also discuss the machine design with respect to operating, repairs and maintenance and cleaning and sanitation.

Head and Tail Cutting Operation

Due to the simplistic design of this system, no operational restraints have been discovered, providing that the blades are sharpened regularly.

The custom-designed spacers make machine adjustments very easy, so that changeovers in production requirements can be performed without incurring any considerable down time.

Eviscerating Operation

The main cosntraint on the efficiency of the viscerating operation are in ensuring that the individual fish enter in the correct orientation. These are discussed in the previous sections. If the fish enter the eviscerating section correctly, the machine design virtually ensures complete evisceration (see Figure 3). A small proportion of large fish have some remnants of posterior gut remaining due to the intestine not being severed from the anus. However, overall eviscerating efficiency is well within the minimum 90% effectiveness limit as defined in the purchasing specifications.

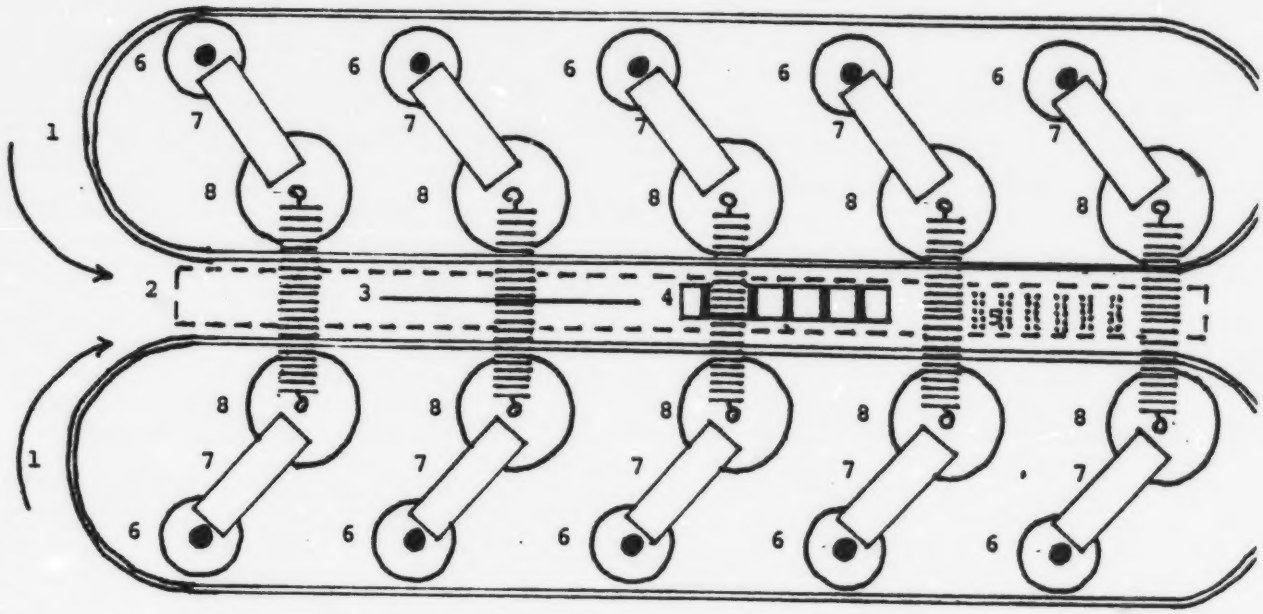
A major concern with the maintenance of the eviscerating section of the machine has been the design of the pivot wheels of the spring loaded belt guide sprockets (see Figure 5). These wheels are of cast aluminum and mounted on stainless steel shafts. If the machine is left idle for any more than three days, aluminum oxide accumulations in the bore of the wheels cause them to tighten on the shafts. As a result, the wheel frequently seizes completely. It is necessary to lubricate the wheels and shafts at every interruption of production. This would have been avoided if the bore was oversized to accommodate a teflon bushing.

Machine Design

Operator

The only design flaw from the operator's perspective is the location of the on/off switch. This is located adjacent to the outfeed chute of the machine. It is therefore necessary for the machine attendant to shut off

Figure 9 Schematic Drawing of Eviscerating Section of Shoal Fish Eviscerating Machine showing detail of spring tensioned fish guide sprockets and drive chain, viewed from above



1. Drive Chains
2. Guide Plate
3. Cutting Blade
4. Eviscerating Wheel
5. Nylon Brush
6. Pivot Wheels
7. Connecting Bars
8. Guide Sprockets
9. Tension Springs

the machine by raising the head cutting blade safety guard. The other alternative is for one of the feeders to leave the work station to use the switch. In either case, the machine can only be re-started by using the main on/off switch. This delay in shutting off the machine often results in a machine blockage build up, resulting in longer down times to clear the machine before re-commencing production.

It is recommended that when future models of this machine are constructed, the switch be relocated to a position adjacent to the machine feeders.

With respect to operator comfort, the persons employed on the machine to date have had no negative comments with respect to fatigue due to over reaching, or unsuitable working height of the table.

Repairs and Maintenance

With the exception of certain problems involving eviscerating operation, the maintenance personnel have found the machine very easy to maintain with respect to routine procedures such as knife sharpening and lubrication. Machine adjustments other than head/tail cutting blade separation are vary and require considerable experience before optimum operating settings are achieved. However, these fine levels of adjustment enable a variety of sizes of fish to be processed through the machine, thus enhancing its adaptability as opposed to a non-adjustable or step adjustment machine.

No repairs have had to be performed to date, with the exception of re-riveting two buckets on to the infeed conveyor which were accidentally broken off during clean-up.

Cleaning and Sanitation

The cleaning of the infeed hopper, belt and head and tail cutting mechanisms is very easily performed, and can be affected by the use of cleaning foam and high pressure spray. To clean the eviscerating section effectively, large debris which is caught in the guide belt and guide sprockets must first be removed manually. This is a standard practice with all fish processing machinery. The area to be manually cleaned is easily accessible by the raising of the entire side panel. Once completed, further cleaning is performed using cleaning foam and high pressure spray. The major benefit with respect to cleaning, is the complete separation of all processing components from the drive mechanisms and motors. This means that their are none of the limitations in cleaning, normally due to avoiding large volumes of water around electric motors.

During processing, heads, tails and viscera are continuously flumed away from the machine, preventing accumulations of debris in the working area, and washdowns of the machine can be readily performed during work breaks.

COST EFFICIENCY

A previous development project between Department of Fisheries and Oceans, Development Branch, and P. Janes and Sons Limited, conducted in 1987 showed that the direct labour input needed to produce a completely eviscerated capelin by a manual operation was so high that the finished products would meet total price resistance in the market place. This was

the main rationale in initiating this project to investigate the economic feasibility of mechanical evisceration.

Due to increased throughputs by mechanical evisceration, all support labour such as defrosting, sanitation and supervision is decreased proportionately as there is no increase in the net labour input in these job categories.

Cost analyses have shown that at initial machine start up, the direct cost of evisceration only, decreased to 29% of a manual operation. After two weeks of machine experience, this improved significantly to 21% of a manual operation.

Using breaded capelin production as a model on which to base the cost efficiency of the machine operation, the final direct production costs were reduced to 59% of those derived from a manual eviscerating operation. Labour costs had increased by 4% during the period between these two productions. If this is factored into the cost analysis, the actual decrease is 42%.

In addition to breaded capelin production, the eviscerating machine has also been utilized in the preparation of capelin for canned capelin products. A total of 56,000 cans of smoked capelin, and capelin in tomato sauce were produced, in which significant labour cost reductions were achieved over previous production runs, in addition to the quality improvement of the product due to the capelin being completely eviscerated.

The mechanical evisceration of male capelin also enabled P. Janes and Sons Limited to produce an IQF Dressed Capelin, which due to high labour costs, and poor quality due to remaining gut material, was not previously feasible.

SUMMARY

The Simnor shoal fish eviscerating machine presently on trial in the Hant's Harbour plant of P. Janes and Sons Limited is a modified machine, originally designed to process smelt from the Great Lakes Fishery. Modifications were jointly discussed between the manufacturer and end user in order to meet detailed purchasing specifications.

To date, the specifications in relation to processing requirements have been met, with the exception of the operator infeed rate. It is not felt that the specified figure of 140 fish per minute with two operators ie: 70 fish per operator minute, is achievable when processing defrosted fish. This is a result of the operators having to cull out damaged and bent fish while feeding the machine. It is felt that this figure may be obtainable when processing fresh capelin, although pre-size grading may be necessary. Machine performances will be evaluated further during the 1988 capelin season.

The overall machine design is good with respect to operating, repairs and maintenance, and cleaning and sanitation. It is suggested that teflon bushings be installed on the guide sprocket pivot wheels in the viscerating section of the machine and that the main on/off switch be relocated to a position within reach of the machine feeders. When processing defrosted capelin, it may be necessary to design and install an automatic oiling system to lubricate the interior surface of the infeed buckets, thus minimizing the adherence of capelin to the buckets.

The cost effectiveness of a machine operation for eviscerating capelin has reduced direct production costs of all capelin products which require that the capelin be dressed. In the cases of breaded capelin and IQF dressed capelin, this has had the effect of transforming production into an economically feasible proposition.

Further production experience is necessary to enable optimum machine set up adjustments to be made. Final machine evaluation will only be possible when fresh male capelin are processed in June and July of 1988. A final report will be drafted after these production figures have been fully analyzed.